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A Comparison of Wind Speed Data from Mechanical and Ultrasonic Anemometers

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This study compared the performance of mechanical and ultrasonic anemometers at the Eastern Range (ER; Kennedy Space Center and Cape Canaveral Air Force Station on Florida's Atlantic coast) and the Western Range (WR; Vandenberg Air Force Base on California's Pacific coast). Launch Weather Officers, forecasters, and Range Safety analysts need to understand the performance of wind sensors at the ER and WR for weather warnings, watches, advisories, special ground processing operations, launch pad exposure forecasts, user Launch Commit Criteria (LCC) forecasts and evaluations, and toxic dispersion support. The current ER and WR weather tower wind instruments are being changed from the current propeller-and-vane (ER) and cup-and-vane (WR) sensors to ultrasonic sensors through the Range Standardization and Automation (RSA) program.

The differences between mechanical and ultrasonic techniques have been found to cause differences in the statistics of peak wind speed in previous studies. The 45th Weather Squadron (45 WS) and the 30th Weather Squadron (30 WS) requested the Applied Meteorology Unit (AMU) to compare data between RSA and current sensors to determine if there are significant differences.

Approximately 3 weeks of Legacy and RSA wind data from each range were used in the study, archived during May and June 2005. The ER data spanned the full diurnal cycle, while the WR data was confined to 1000-1600 local time. The sample of 1-minute data from numerous levels on 5 different towers on each range totaled more than 500,000 minutes of data (482,979 minutes of data after quality control). The 10 towers were instrumented at several levels, ranging from 12 ft to 492 ft above ground level. The RSA sensors were collocated at the same vertical levels as the present sensors and typically within 15 ft horizontally of each another. Data from a total of 53 RSA ultrasonic sensors, collocated with present sensors were compared. The 1-minute average wind speed/direction and the 1-second peak wind speed/direction were compared.

The overall results follow:

- Overall Average Wind Speed: Present 8.56 kt, RSA 8.87 kt, RSA – Present = + 0.29 kt, standard deviation = 1.17 kt
- Overall Peak Wind Speed: Present 10.72 kts, RSA 11.78 kt, RSA – Present = + 1.06 kt, standard deviation = 1.59 kt

The AMU also examined each Present/RSA pairing for consistency in wind speed and wind direction. The most consistent sensors were used to define a composite average-Present/RSA comparison.

Comparisons of the consistent composite were slightly different than the overall comparison cited above.

- Composite Average Speed: Present 8.80 kt, RSA 9.14 kt, RSA – Present = + 0.34 kt, standard deviation = 0.94 kt
- Composite Peak Speed: Present 10.95 kt, RSA 11.93 kt, RSA – Legacy = + 0.98 kt, standard deviation = 1.38 kt

From a technical point of view the small differences in average wind speeds reported by the Present and RSA sensors are statistically significant, due to the small standard deviations (0.94 kt) and the large sample size. In addition, the average difference in the average wind speed was less than the expected error from the combined precision of the sensors (0.50 kt). From a practical point of view the differences in peak wind speeds are more important, indicating that the change to ultrasonic sensors can be expected to result in an increase in reported peak wind speeds. An increase in peak wind speeds would result in a decrease of launch availability, depending on the LCC threshold wind speed. For example, the probability of peak wind speeds at 20 kts or less using the ER Present data was 95.2%. For the same 20 kt threshold the ER RSA data showed a probability of 92.3%, a potential loss of launch availability of up to 2.9%

Full details are available under 'final reports' at http://science.ksc.nasa.gov/amu/home.html.